CHAPTER 8

FIRE PREVENTION

8-1. Introduction

The purpose of fire prevention is to eliminate fire hazards, or elements which cause fire to occur, or conditions which will contribute to the spread of fire. The firefighter's utmost concern is the prevention of destructive fires. Prevention saves the effort and expense of extinguishing them. It is DA policy that arrangements be made to have firefighters perform fire prevention duties away from the fire station and at the same time be available for fire call.

a. To prevent a situation from being hazardous, one of the three elements of the fire triangle must be removed. Of the three, heat is the undetermined condition, the one which is most generally considered from the standpoint of fire prevention.

b. Effective fire prevention requires the establishment of a well-planned program and the organization, publicity, support, cooperation, inspection, and supervision to implement and maintain it. It also requires the instilling of personal responsibility and interest in individuals so that they will help prevent the loss of property and life by fire due to carelessness. The personal interest and concentrated effort of all concerned, from commanders to supervisors to individuals, is essential if the fire prevention program is to be successful.

8-2. Cigarettes and Matches

Smoking is the greatest single cause of fires. The careless discarding of matches, the dropping of hot ashes, and the careless leaving of lit cigarettes are the principal infractions of smokers that cause fires.

a. Smoking does not appear to be a serious cause of fire to most individuals because the great majority have never started a fire by smoking, that they know of. Actually, *anyone* who has carelessly discarded a lighted cigarette may be guilty of having started a fire, even though the cigarette may have been originally dropped upon concrete, metal, or barren earth. Paper, having a low flash point, is very easy to burn by a lighted cigarette. Thus, emptying of ashtrays into a wastepaper container is foolish even though the cigarette butts apparently are not smoldering.

b. Any type of match may start a fire, but the possibility of its doing so varies greatly according to the type of match. The proper safety match has a head that will not fly off when struck and a stick that is treated to eliminate afterglow. The use of good safety matches should be required, especially in areas near flammable gases, vapors, and materials.

8-3. Waste

Waste materials and rubbish are great contributors to the start and spread of fire independent of flammable liquids.

a. Waste materials containing oil have spontaneous ignition characteristics and are very likely to cause fires. A high standard of cleanliness and the complete elimination of loose rubbish from building interiors are unquestionably among the greatest factors in fire prevention. It is the duty not only of fire-inspection personnel but also of all personnel occupying the building to see that poor housekeeping habits are eliminated. When it is impossible or very inconvenient to remove flammable rubbish from the building immediately, such material should be kept in fireproof or fire-resistant containers or inclosures.

b. Clean waste, although not as hazardous as used or reclaimed waste, has occasionally been reported as a source of spontaneous ignition. Consequently all waste, excelsior, straw, sawdust, and burlap should be kept in metal tins with self-closing covers to prevent the admission of oxygen and thus the ignition of the heated combustible substance.

c. Spontaneous ignition occurs under extremely variable conditions. It is difficult to state that a

specific quantity of flammable materials will or will not ignite independent of external heat, since the naked eye cannot see all of the contents of the material ; furthermore, the time factor required for ignition rnay range from minutes to months.

8-4. Sparks

Live sparks from chimneys and stacks, refuse burners, and other similar sources must be given priority consideration. Spark-arresting screens can be installed over the openings, but their efficiency is limited. A large mesh screen will let many sparks escape. A small mesh screen will soon become carbon congested and impede the passage of smoke. The best procedure is to use medium mesh screens of heat-resisting alloy metal. These screens will require periodic cleaning. Medium mesh will allow only those sparks having a limited "glow life" to escape, retaining those large and more dangerous embers in the stack. During periods of low humidity and high wind velocity, special precautions must be taken depending upon the fire risk in the immediate area.

8-5. Mechanical Devices

Engines of any type, or other machines in which friction is created, are possible sources of fire.

a. A common example of this is a fire caused by overheated bearings. Wherever there are engines, there should be frequent elimination of lint and dust from the immediate surroundings of the moving mechanical device. Also all excessive flammable lubricants should be removed promptly.

b. Grinding wheels and other spark-producing equipment are a frequent cause of fires and should not be permitted in areas which might contain highly flammable gas or vapors. Neither should flammable materials of any type be left in an area where sparks may fall upon them.

c. Blower systems including all duct installations, whether used for ventilation, air conditioning, or dust and vapor elimination, are fire hazards. Most dust, including that of some metals, is an explosion hazard where a spark is possible. These sparks may be struck by fan motors, overheated fan bearings, or the movement of the fan against surrounding metal. Blower fans or their metal housings should consist of nonferrous metal. The ducts must be of metal and free from contact with wood and other flammable material. They must also contain parts which will permit frequent cleaning and compartment dampers which will isolate the fire to a single section if prevention fails.

8-6. Effect of the Sun

The sun frequently is responsible for fires, though it is usually assisted by some manmade implement.

a. A fire inspector must be especially observant of these implements, because under most conditions they are extremly difficult to detect as fire hazards. For example, forest fires have been known to start from discarded bottles or other fragments of glass left by careless campers. The sun's rays, shining through a piece of glass which may be so ideally curved and placed as to act as a magnifying glass, are concentrated so as to ignite a piece of paper. Similarly, curtains can be ignited by a window pane containing a bubble or some other irregularity. Fire may also occur from such sources as laboratory flasks, fish bowls, water bottles, concave mirrors (which reflect heat), and other common sources. The sun also contributes to spontaneous heating, thus aiding ignition. During warm seasons when buildings are closed for the weekend, sprinkler heads located beneath skylights and in attic spaces may be discharged, often resulting in considerable water damage.

b. The possibility of fire being started by the sun is somewhat remote. However, since numerous conditions may create these so-called freak fires and any one fire may completely destroy a building or many buildings, these possibilities deserve careful consideration.

8-7. Buildings Under Construction

Buildings in their various stages of construction usually have more fire hazards than they do after they are completed.

a. Probably the primary reason for this is the fact that most people cannot visualize a building burning down completely before it is put up completely. Therefore, there is usually no fire-extinguishing equipment immediately available. On an Army base, construction operations are common. The loss of any of these projects by fire, regardless of their stage of completion, may cause severe hardships and serious delays. For this reason, it is recommended that fire extinguishers be made available in proper quantity and be adequately distributed throughout the project. All excess

wood and other combustible materials should be removed promptly. Heaters and heating equipment should be strong and safe. They should be located where they will not ignite other material, and must be constantly attended.

b. Combustible materials should not be stored in or near buildings under construction. Gasoline and other volatile liquids should be segregated and stored in standard safety containers, preferably underground if the liquid is kept in any large quantity. Windbreakers and tarpaulins should be properly secured, and their location should be checked for possible fire sources. Welding should be supervised and all adjacent combustible material either removed or adquately protected from the flame and flying embers. Stairways and exits must be clear and properly maintained in order to enable quick evacuation of the structure and for extinguishing the fire in any location.

8-8. Heating Systems

Heating systems are a common source of fire during winter seasons in most latitudes. Heating units and their conditions of installation are so variant that it is impossible to deal with each specific hazard in detail here. 'The best procedure is to inspect each heating system while it is out of operation and also while it is in various phases of operation, and then take the necessary action to eliminate hazards. Any source of heat is a potential fire hazard unless it is so constructed and installed that it will not heat nearby combustible materials to a point where they may ignite. Heating devices, for a proper margin of safety, should be so installed that exposed woodwork will not be heated in excess of 160° F. (71° C.). Normally, building codes require that heating units and their conveying ducts be installed a given minimum distance from combustible materials. This condition seems somewhat unimportant if we do not take the ventilation and circulation aspects into consideration.

a. *Insulation.* Insulation alone is not a solution to safe heating. Heat from a stove base, for example, has been known to penetrate metal, brick, and asbestos and to char the wood beneath when these materials had no air space below them. Long periods of high temperatures have been known to cause fires under apparently safe conditions. In large rooms, a reasonable clearance between the heating device and the combustible material is the primary requisite. In small rooms the lack of space may restrict the proper clearance and sometimes even adequate insulation to supply the proper safeguard against the ignition of combustibles. This requires a closer watch on the quantity and consistency of heat and more careful inspections.

b. Furnaces. Stationary heating devices are rated in three grades: low, medium and high. Low-grade furnaces develop temperatures up to 600°F.(315°C.). Medium-grade furnaces develop temperatures from 600° F. (315° C.) to 1,500' F. (815°C.). High-grade furnaces create temperatures in excess of 1,500' F. (315° C.) and require 30 feet (9.15 meters) of frontal clearance, 10 feet (3 meters) on the rear and sides, and 15 feet (4.6 meters) of overhead clearance.

c. *Steampipes.* Steampipes of any type may, in the course of time, make charcoal out of wood with which they are in contact. This charcoal is subject to spontaneous ignition because it absorbs great quantities of oxygen from the atmosphere. Steampipes should be wrapped in asbestos or magnesia insulation which has a minimum of 1 inch (2.54 centimeters) of clearance from all woodwork.

d. Ranges and Ventilating Systems. Massive ranges and ventilating systems present great hazards in dining halls and &her locations where food is prepared for large groups. Hot grease boiling over containers, the residue in the hoods, the area over the range, and the space within the ducts leading away from the hoods are the chief sources of fire danger. Ducts should be made of not less than No. 18 U.S. gage steel, tightly riveted at the joints, so that if the grease residue ignites and burns there will be a minimum of damage to the building itself. Access ports should be prwided in exhaust ducts to enable periodic cleaning.

e. *Stoves.* Coal and wood stoves should be mounted on a fire-resistant floor and should follow the clearance and ventilating requirements of a low-grade furnace. 'The stovepipes must be properly installed and must not pass through confined spaces in which an ignition temperature could build up. Stovepipes should be properly supported, kept in good repair, and cleaned regularly.

8-9. Electricity

Electricity, if improperly used, may easily become a major fire hazard and a serious source of danger to personnel.

a. When the simple and proper rules of installation and use are followed, electricity is a superior source of power, illumination, and heat. It may become a fire hazard by overheating, arcing or sparking. *Overheating* is a condition where an overload of electrical current is passed through a wire and the internal heat created by the overload burns through to ignite the insulation covering the wire. This insulation then ignites adjacent combustibles. When an electric motor is overworked or defective, it overheats, and fire results. A single electrical outlet or wire used as a power supply for too many electrical implements will cause overheating. *Arcing* is a sustained luminous glow which is formed under certain conditions when a break is made in an electric circuit. An arc light and the breaker points in an automotive distributor system are examples of arcing. *Sparking* is an electrical condition in which light is created, accompanied by a sudden disruptive discharge, between two conductors separated by air or some similar medium. The action of spark plugs in an internal combustion engine is an example of sparking.

b. To minimize these hazards from electrical sources, the equipment and installation should be standardized and properly maintained. It is the job of tire-inspection personnel to see that these hazards are completely eliminated. Being certain that no fires will start from an electrical source today gives no assurance of fire safety next week. Inspectors unable to visit each building daily must help educate the occupants on what constitutes a fire hazard.

c. Electrical installations are made in accordance with national electrical codes, state laws, and municipal ordinances. If these provisions are followed, fire hazards are decreased but certainly not eliminated. Deterioriation by use, abuse, and age often requires the replacement of electrical wires and their associated implements. Frequently, crude installations and use of electrical fixtures make for flagrant violations of fire safety rules.

d. Electrical circuits carry currents of varied intensity. When current is suddenly cut off, whether by accident-such as by a loosened contact at a terminal-or by intention, an arc is produced. The magnitude of this arc depends upon the current and amount of voltage involved. At all times the temperature of this arc is very high, and it can ignite combustible materials. In addition, the metal of the conductor usually fuses. This hot, flying metal, along with the flying sparks, amy also ignite combustibles and frequently causes ignition of the wire insulation.

e. 'The electric wire, or conductor, as it is technically termed, is normally a negligible consideration from the standpoint of 'overheating tendencies. However, there is a possibility of overloading, for each conductor is rated with a certain maximum capacity. Fire hazards occur in two ways when this capacity limitation is exceeded: through the deterioration of the insulation (which exposes the wire) and through the creation of excessive heat.

8-10. Fuses and Other Safety Devices

Many devices have been designed to give overcurrent protection. These devices open the circuit and cut off the current when the electrical flow reaches a given maximum.

a. The most common of these devices is the *fuse,* which contains a strip of metal that overheats and melts when the current exceeds the fuse capacity, thus breaking the circuit. Fuses consist normally of two common types, the plug type and the cartridge type.

b. Another protection against overcurrent is provided by the circuit breaker. This device automatically cuts off the flow of electricity when the current becomes excessive.

c. All overcurrent protective devices must be so designed as to confine the arc harmlessly within themselves when they go into operation. Clean contacts at the fuse terminals or boxes are important because dirt can cause overheating and the blowing of fuses.

d. The hazards most likely to be found in overcurrent protective devices are as follows :

(1) Plug fuses which have blown out and have had pennies inserted behind them or wires inserted between the broken contacts.

(2) Fuses of a capacity higher than desirable, or circuit breakers with too high a setting.

(3) Fuses or circuit breakers in poor mechanical condition.

(4) Unconfined fuses in an area containing combustible material.

(5) Fuse cabinets with open or missing doors.

(6) Corroded fuses, inclosures, or circuit breakers.

(7) Refillable fuses containing additional metal strips.

(8) Cartridge fuses which have been blown and replaced with nails, wires, or other metal.

(9) Cricuit breakers made useless by the tying or blocking of the tripping element.

8-11. Wiring and Switches

There are several recognized methods of installing electrical wiring. Only rigid conduits should be used where gasoline vapors may be present. No conductor should be installed, even temporarily, that does not conform to all safety requirements.

a. The hazards most frequently found in electrical wiring are as follows:

(1) Overloaded conductors.

(2) Corrosion of the conductor coverings.

(3) Corrosion and loosening of supports.

(4) Covers of outlet boxes or junction boxes removed.

(5) Wiring installed for temporary use.

(6) joints not properly put together.

(7) Flexible conductors hung over nails or other makeshift contrivances which may cause wear and create arcing or sparking.

b. In electrical switches the chief hazard is caused by arcing when the switch is operated. Switches should contain an inclosure that will confine any arc that might occur. The most prominent hazards in switches are corrosion, faulty mechanical condition resulting from use or abuse, overheating due to poor contact or an overload of current, inclosures absent or ineffective, and contacts burned or pitted where the circuit is opened or closed.

8-12. lamps

The principal types of electric lamps are vapor, incandescent, and arc.

a. In locations where flammable gases, vapors, or dust are present, the improperly equipped lamp becomes an explosion and fire hazard. Mercury arc lamps are a spark hazard if not confined. The gas-filled lamps now in common use generate enough heat to ignite combustibles in contact with, or close to, the globe. Neon lamps require a high-voltage supply and offer a hazard from the arcing which this high voltage may create. Portable lamps are frequently used in damp or wet locations. This practice presents both a fire hazard and a personal safety hazard.

b. The hazards most common in portable lamps are fragile sockets, the use of defective or unapproved cord, the use of frail lamp guards or the absence of any guard, and the failure to provide a disconnection release in the event of strain on the cord. Lamp sockets are not great fire hazards if an approved type of socket containing the correct load limit is used and if the component socket parts are properly assembled.

c. There are many lamps in use that are of substandard construction. When making a fire safety inspection, inspect these lamps carefully. A substandard lamp is a definite fire hazard.

8-13. Flexible Cords

Flexible cords should be used only when absolutely necessary, for their use constitutes a distinct fire hazard unless careful attention is given to their treatment and condition. Flexible, portable cords are subject to much abuse. They contain a conductor of fine strands of wire with an insulating covering of small dimensions, which frequently consists of combustible materials. Instances have occurred where metal-wheeled vehicles have passed over portable, flexible cords and caused critical losses by creating an arc in the presence of gasoline vapors. A cord should be lifted over any heavy moving object instead of the object passing over the cord. The better portable cords are covered with a heavy rubber outer jacket. Constant observation and maintenance of these cords is a paramount safety precaution. Complete replacement of a cord is necessary when appreciable wear becomes evident.

8-14. Motors and Generators

Electric motors and generators present a definite fire hazard, since they can produce arcs or sparks and frequently overheat and burn out because of overload.

a. The motor frame should be suitably inclosed. Combustible material should be kept away from the vicinity of motors and generators to prevent hazardous conditions resulting from arcing and sparking. Overcurrent protection will safeguard against overloading.

b. The following are the common precautions required in the use of electric motors to safeguard against fires. They must be kept away from combustible material and out of damp places which subject the motor to corrosive vapors. The overcurrent must not exceed 125 percent of its rated capacity. Lint and dust must be kept off the top of

the motor. Special precautions must be taken when starting an electric motor near combustible material because of the arcs and heat produced by the motor. Low voltage at the terminal must be corrected because it will cause the motor to burn out and start a fire. Overloading also produces heat and becomes a fire hazard.

8-15. Static Electricity

Static electricity is generated to an appreciable extent in many industrial and manufacturing operations. It is a factor which requires major consideration where aircraft are used.

a. Previously it was believed that static electricity was generated only by friction between two unlike substances. It is now known that static electricity is created by contact between two unlike substances even though no friction is present. Static electricity is known to be a serious fire and explosion hazard in the presence of volatile flammable liquid, flammable gases, highly ignitible fibers, and combustible dusts.

b. In areas where the hazard is great, it is advisable to replace belts with chains and gear drives to eliminate the generation of static electricity. When the construction features cannot be changed to prevent the generation of static electricity, it is also advisable to ground all metal parts which may accumulate an electrical charge. The atmosphere normally is a nonconductor of electricity, but ionized air will normally draw static electricity from charged metal implements. Static neutralizers may be installed to do this.

c. Humidity is an important factor in the ability of static electricity to drain from highly charged metal objects. Where high humidity is present, surface resistance is reduced, and electrical charges are drained off almost as they form. A humidity of 40 to 50 percent generally prevents any quantitative buildup of static electricity.

d. Static electricity is created when gasoline or similar flammable liquids are passed through a hose, poured from one container to another, filtered, or subjected to velocity in almost any manner, These dangerous static charges frequently cause serious fires and explosions unless preventive measures are taken.

e. When gasoline is discharged through a hose, a copper wire should be installed from the pump through the hose to the nozzle, and the nozzle should be kept in contact with the metal receptacle at all times. In many cases, such as in aircraft tanks, a separate wire with a male connection is plugged into a static electricity drain installed near the tank opening. This device should be plugged in before the gasoline is allowed to flow through the hose.

8-16. General Storage Precautions

In theaters of operations, where materials are stored outside or where they are protected in warehouses, large quantities should be divided and dispersed to discourage fire propagation. At the same time, ample space should be allowed for extinguishment activity and the firefighting equipment. Fire losses are greatly decreased if the various classes of supplies are stored systematically.

a. *Fire Extinguishers.* Fire extinguishers should be strategically placed in storerooms and other locations where flammables are present for controlling fire at its outbreak. Instructions should be provided which inform the occupants of the buildings to call the fire department immediately if fire occurs, then attempt to put out the blaze with first-aid extinguishers. If more than one person is present, one should turn in the alarm while the rest fight the fire.

b. Sign. Signs should be conspicuously placed where special precautions are necessary which order "no smoking" and other essential precautions. A recommended procedure in the event of fire should also be given. Metal containers, plainly marked for the intended contents, should be placed where needed and a safe distance from structures and flammables. Both civilian and military personnel should report any violations of fire regulations without delay to the responsible person in charge.

c. *Fuels.* Engine fuels, lubricants, gasoline, and coal should be stored separately on bases that are without previously installed permanent facilities. Gasoline and oil drums should be stacked horizontally in double rows, butt to butt. Flammable liquids should be placed on a slope away *from* danger so that the free liquid will drain off in a safe direction. When storage involves great quantities of liquid fuel, it should be segregated into group volumes as small as practicable, with earthen dikes erected around each group to confine the burning limits to single areas or groups.

d. *Ammunition.* All types of ammunition should be stored in isolated areas, in individual piles, separated by enough space to allow passage of vehicles for fire extinguishment and for removal of

exposed ammunition to a safe area during the course of a fire. If possible, ammunition piles should be segregated to prevent an individual pile from exploding another or a series of others, causing the complete loss of materials in the area. The distance between piles can be determined by the type of ammunition and its characteristic reaction upon detonation.

8-17. lightning

Lightning is a frequent cause of fires. At -certain periods in past years it has led the field from the standpoint of monetary losses. 'On bases where there are wooden structures, flammable liquids, and ammunition powder, precautions against lightning must be taken. This is especially true in some sections of the United States where the lightning hazard is present for almost 100 days out of every year.

a. Lightning rods prevent damage from lightning if they are properly installed. The rods must extend from 24 inches (0.6 meter) to 60 inches (1.5 meters) above the highest projection of a structure with grounding connections distributed symmetrically around the base of the structure. At least two down conductors and ground connections should be made at the opposite horizontal ends of the structure, The lightning rods, conductors, and grounding connections should be made of copper. Where several lightning rods are installed on a structure, they should be bonded together by horizontal conductors following the roof edges, roof ridges, and parapets of the structure. Likewise, all down or vertical conductors should be connected to bonded grounding connections. All conductor cables should be not less than 1'7 American wire gage (AWG).

b. All oil tanks, whether of steel or some other material, should be grounded. Direct lightning strikes on the tank may be averted by a network of wires, properly grounded, at least 6 feet (1.8 meters) above the tank. A series of steel masts may be erected around the entire tank farm at such a height that they will not impede ground activity. The masts are then joined with a series of wires which form a horizontal pattern.

c. Structures containing stored explosives need protection not only against direct lightning hits but also against induced sparks caused by a lightning strike in the immediate area. The best location for powder storage is underground or in small individually segregated rooms. These rooms should be covered with earth and equipped with copper cables running across the roof and grounded on each side.

8-18. Painting and Spraying

In any location where paint and lacquer spraying is performed, whether it involves vehicles, aircraft, or simply structural interior decorating, it is always fairly certain that flammable solvents, ignitable at low temperatures, are present in the atmosphere. Ventilation is the best insurance against vapor ignition. Each compartment or spray booth should be equipped with an individual exhaust duct, including a sparkproof fan. The use of heat for drying purposes increases the fire hazard in paint spray areas and increases the necessity for caution. Electrical hazards are the greatest source of fire danger in a paint spray area. Spontaneous ignition and careless operation and maintenance habits are also high on the list of fire hazards.

8-19. Miscellaneous

Common deficiencies and conditions, not otherwise covered in this chapter, which require attention during inspections are as follows:

a. Sprinklered Buildings. Arrangements should be made to keep at least 18 inches (45.72 centimeters) clearance below sprinkler defectors to reduce possible obstruction to distribution of water. 'For high-piled combustible stock, increased clearance of 36 inches (91.44 centimeters) or more should be provided. Sprinkler heads should not be painted, and painted heads must be replaced. Alterations, extensions, additions, or other modifications to existing buildings should not be made without providing for necessary alteration of the sprinkler system. When new suspended ceilings and similar additions to the building are made, the necessary extension of the sprinkler system may tend to be ovenlooked. New partitions, unless positioned midway between sprinkler heads or lines, require additional sprinkler heads. A change of occupancy may also create conditions that require sprinklers.

b. Automatic Fire Alarm Systems. The same conditions as described in *a* above may occur in buildings in which automatic fire alarm systems are installed. All combustible dormitory type buildings with individual sleeping rooms should have automatic fire alarm systems. This is particularly true of former open bay barracks of com-

bustible construction which have been modified for individual or two- to four-man sleeping rooms.

c. ***Interior Finish and Insulation.*** Interior finish and insulation in Army buildings is required to be noncombustible (flame spread rating of not higher than 25 as tested in accordance with ASTM E 84). Combustible material such as plywood, low density fiberboard, or similar material, often installed by troop labor or self-help, should be removed.

d. Exit Facilities. Inspection should determine the condition of panic hardware, exit lights, and door swing of exit doors. Exit doors should not have blocks or locks or chains installed unless they are unlocked or removed when the building is occupied. Structures must have two exits; excessive dead-end corridors may require additional exits or outside stairs.

e. ***Fire Doom.*** Fire door closing devices should be in good operating condition. The doors should not be blocked. Doors such as stairway enclosure doors should be kept closed.

f. Cleaning with Gasoline. Cleaning with gasoline or similar flammable liquids is prohibited.

g. ***Close-of-Business Inspections.*** This inspection, conducted by the building fire marshal, is an important fire prevention practice, particularly in clubs, theaters, and other places of assembly. Trash and smoking material should be removed from the building and upholstered cushions on furniture turned up. Early morning inspections by the fire department are recommended to determine if this has been done.

h. Hoods. Hoods over kitchen equipment should be equipped with a washable type filter. ‘This filter should be cleaned weekly, usually in the dishwashing machine. The hood and connecting ducts should also be cleaned regularly.